US009449251B2

(12) **United States Patent**
Kinoshita

(10) **Patent No.: US 9,449,251 B2**
(45) **Date of Patent: Sep. 20, 2016**

(54) **IMAGE PROCESSING APPARATUS, IMAGE PROCESSING METHOD, AND MEDIUM**

(71) Applicant: **CANON KABUSHIKI KAISHA**, Tokyo (JP)

(72) Inventor: **Hideyuki Kinoshita**, Tokyo (JP)

(73) Assignee: **CANON KABUSHIKI KAISHA**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/721,116**

(22) Filed: **May 26, 2015**

(65) **Prior Publication Data**

US 2015/0347865 A1 Dec. 3, 2015

(30) **Foreign Application Priority Data**

May 28, 2014 (JP) 2014-110485

(51) **Int. Cl.**
G06K 9/34 (2006.01)
G06K 9/46 (2006.01)
H04N 1/46 (2006.01)

(52) **U.S. Cl.**
CPC ***G06K 9/4652*** (2013.01); ***H04N 1/46*** (2013.01)

(58) **Field of Classification Search**
USPC 382/164, 162, 167; 345/419, 590, 602; 347/19, 257, E27.251; 348/222.1, 348/223.1, 224.1, 225.1, E9.04, E9.052, 348/349, 364, 649, 652; 358/1.9, 296, 504, 358/518; 399/49
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,420,630 A * 5/1995 Takei H04N 9/735 348/223.1
5,539,523 A * 7/1996 Nakai H04N 1/622 358/296
5,831,672 A * 11/1998 Takei H04N 9/735 348/224.1
7,999,822 B2 8/2011 Ishii
8,223,410 B2 * 7/2012 Wakazono H04N 9/735 345/419
8,964,246 B2 * 2/2015 Sakatani G03G 15/0131 345/590

FOREIGN PATENT DOCUMENTS

JP 2008278054 A 11/2008

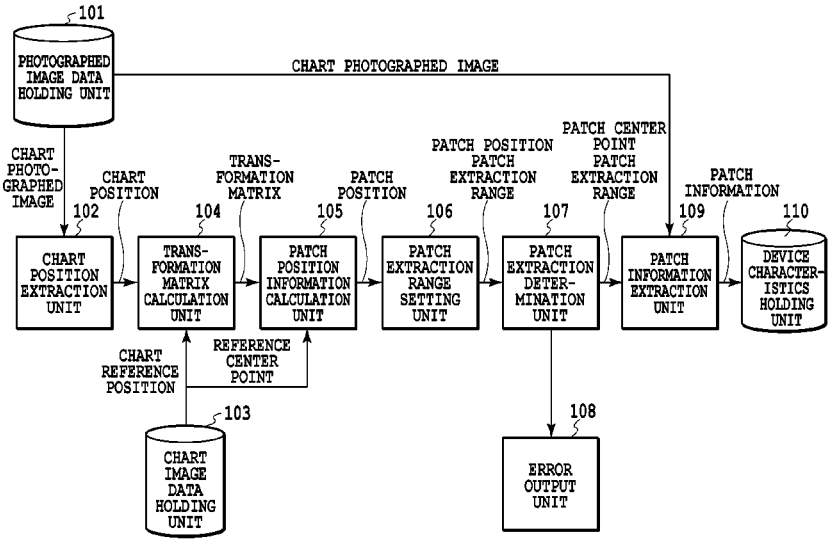
* cited by examiner

Primary Examiner — Anh Do
(74) *Attorney, Agent, or Firm* — Rossi, Kimms & McDowell LLP

(57) **ABSTRACT**

An image processing apparatus that extracts colors of patches from a photographed image data of a chart image is provided. The image processing apparatus includes: a position extraction unit configured to extract information indicating a position of the chart image in the photographed image data; an acquisition unit configured to acquire information indicating a patch position of each patch images in the chart image based on the chart image; a setting unit configured to set an extraction range in accordance with the patch position of each of the patch images in the photographed image data based on the information; a determination unit configured to determine whether or not the set extraction range fits inside each of the patch images; and a color extraction unit configured to extract a color of each patch image.

9 Claims, 14 Drawing Sheets



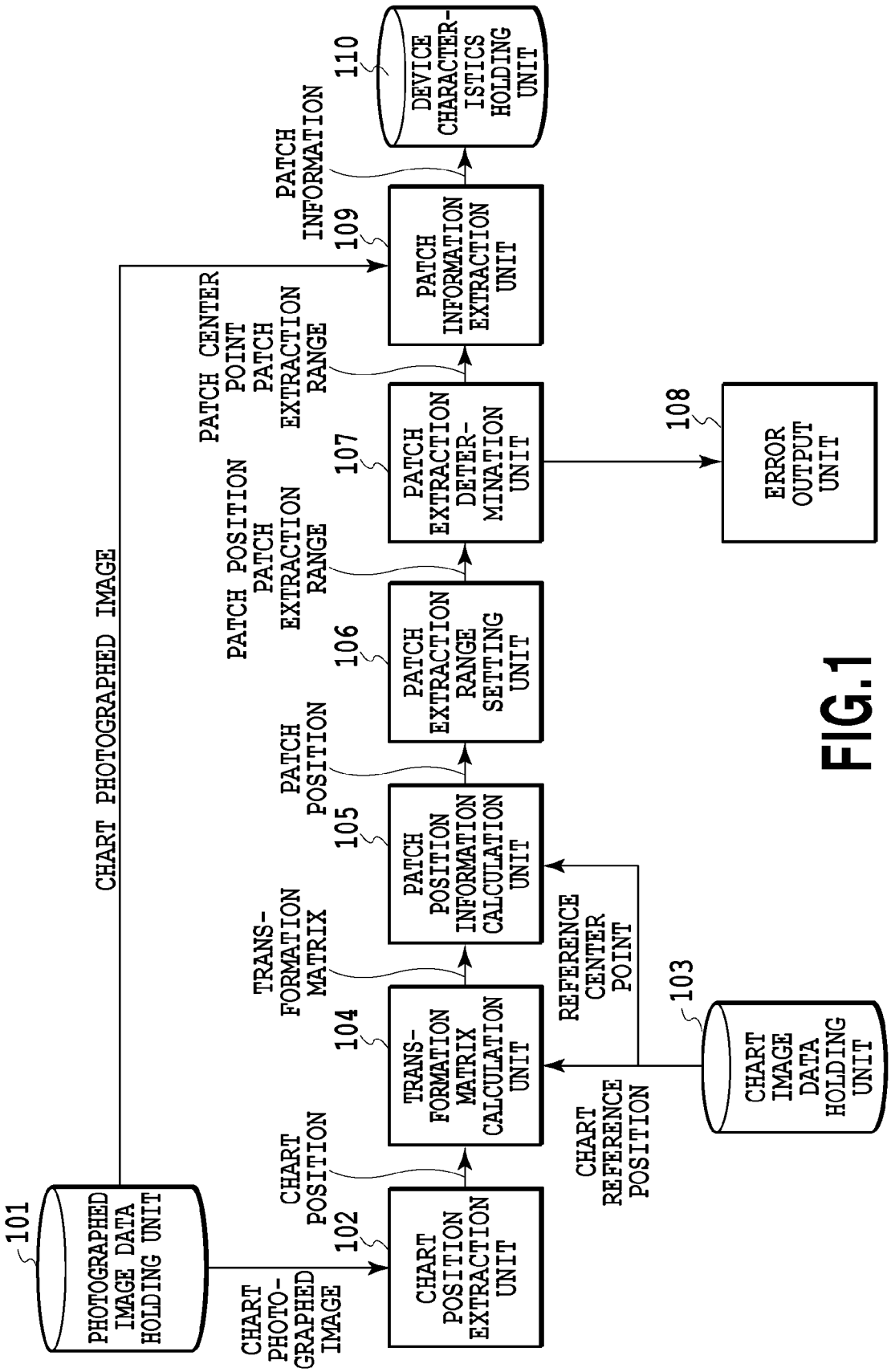

101
PHOTOGRAPHED IMAGE DATA HOLDING UNIT
CHART PHOTOGRAPHED IMAGE
CHART PHOTO-GRAPHED IMAGE
102
CHART POSITION EXTRACTION UNIT
CHART POSITION
104
TRANS-FORMATION MATRIX CALCULATION UNIT
TRANS-FORMATION MATRIX
105
PATCH POSITION INFORMATION CALCULATION UNIT
PATCH POSITION
106
PATCH EXTRACTION RANGE SETTING UNIT
PATCH POSITION PATCH EXTRACTION RANGE
107
PATCH EXTRACTION DETER-MINATION UNIT
PATCH CENTER POINT PATCH EXTRACTION RANGE
109
PATCH INFORMATION EXTRACTION UNIT
PATCH INFORMATION
110
DEVICE CHARACTER-ISTICS HOLDING UNIT
108
ERROR OUTPUT UNIT
REFERENCE CENTER POINT
CHART REFERENCE POSITION
103
CHART IMAGE DATA HOLDING UNIT

FIG.1

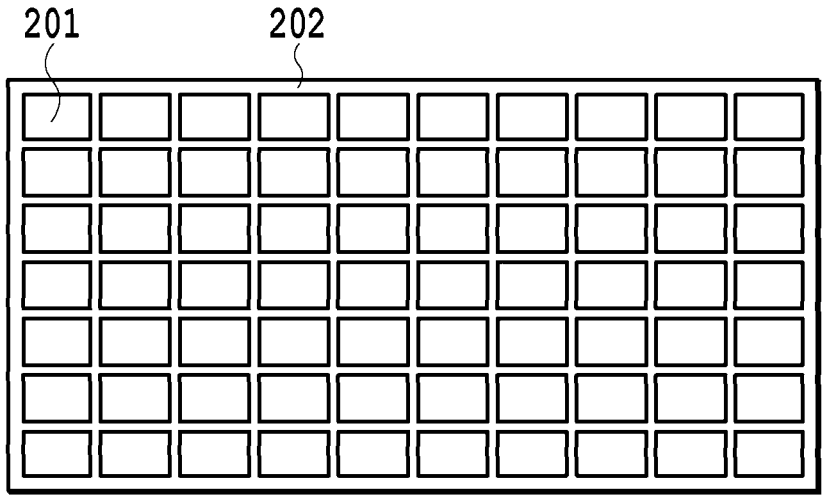


FIG.2A

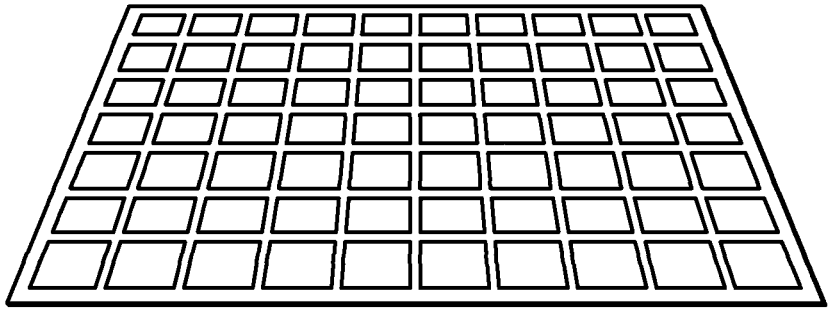


FIG.2B

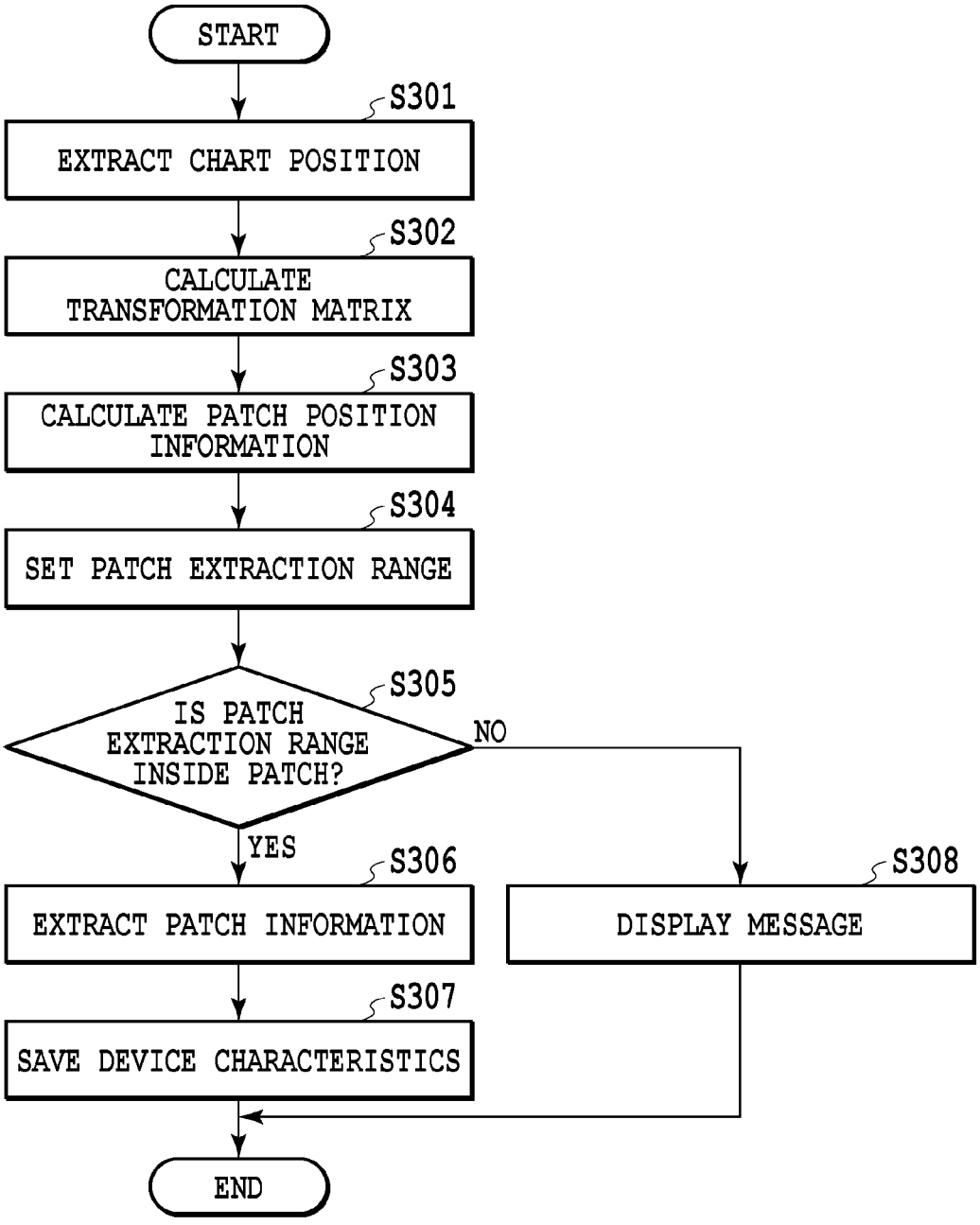

START
S301
EXTRACT CHART POSITION
S302
CALCULATE TRANSFORMATION MATRIX
S303
CALCULATE PATCH POSITION INFORMATION
S304
SET PATCH EXTRACTION RANGE
S305
IS PATCH EXTRACTION RANGE INSIDE PATCH?
NO
YES
S306
EXTRACT PATCH INFORMATION
S307
SAVE DEVICE CHARACTERISTICS
S308
DISPLAY MESSAGE
END

FIG.3

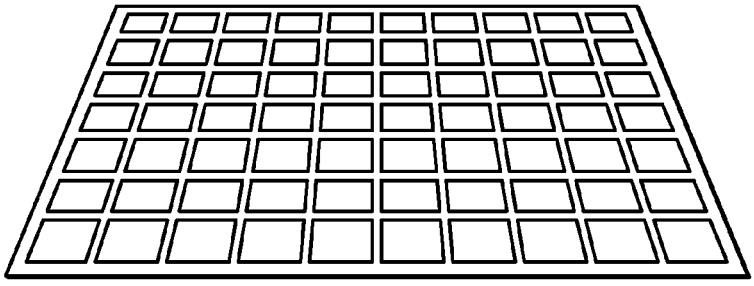


FIG.4A

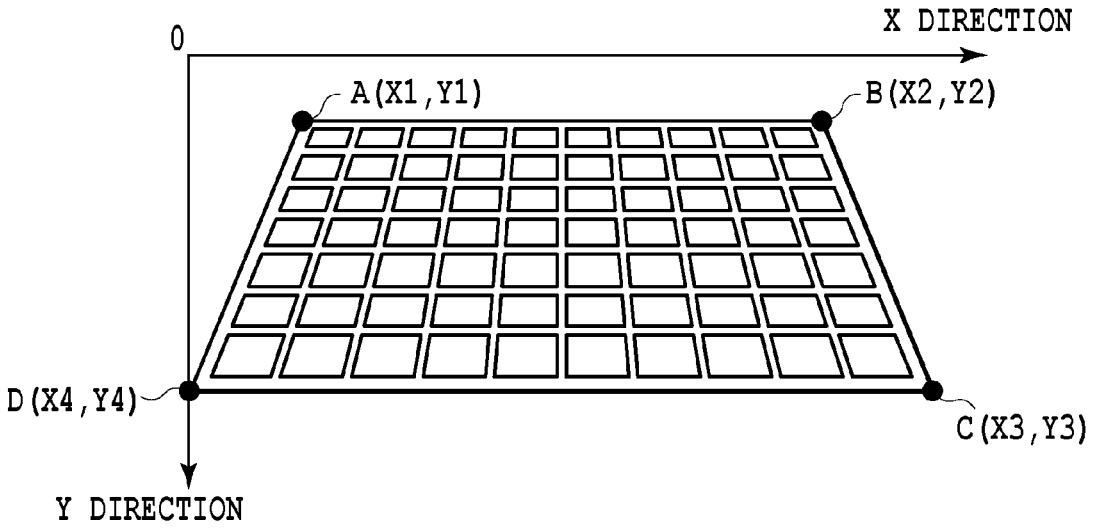


FIG.4B

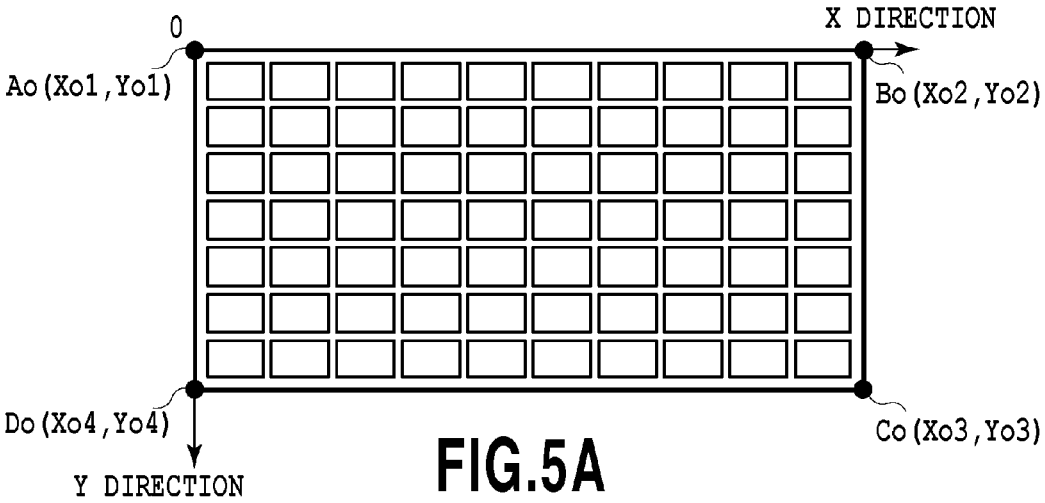

0
X DIRECTION
Ao(Xo1,Yo1)
Bo(Xo2,Yo2)
Do(Xo4,Yo4)
Co(Xo3,Yo3)
Y DIRECTION

FIG.5A

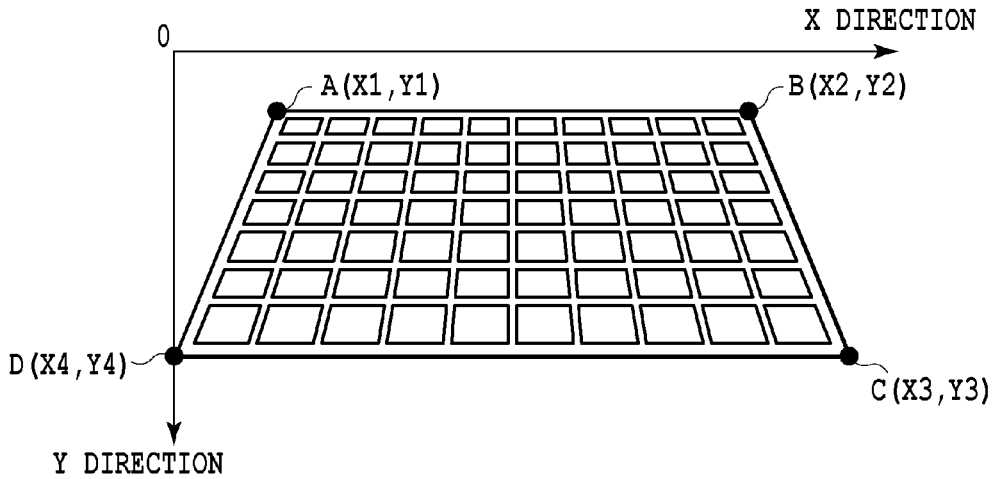

0
X DIRECTION
A(X1,Y1)
B(X2,Y2)
D(X4,Y4)
C(X3,Y3)
Y DIRECTION

FIG.5B

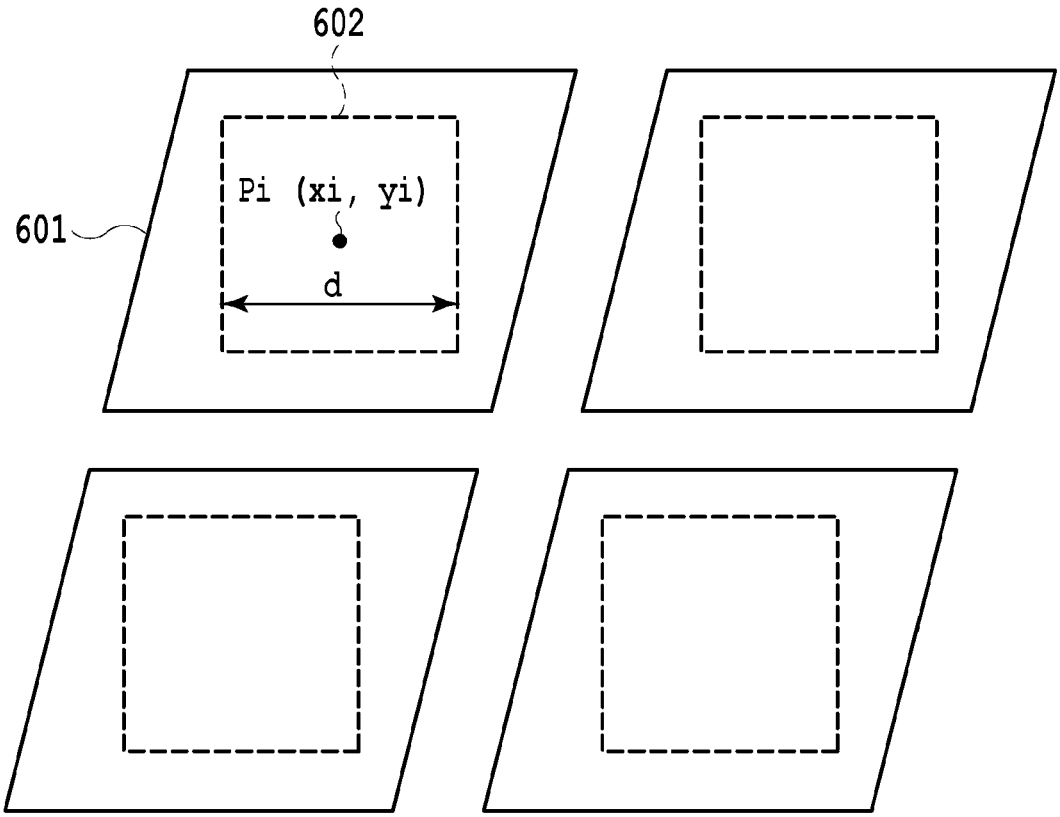


FIG.6

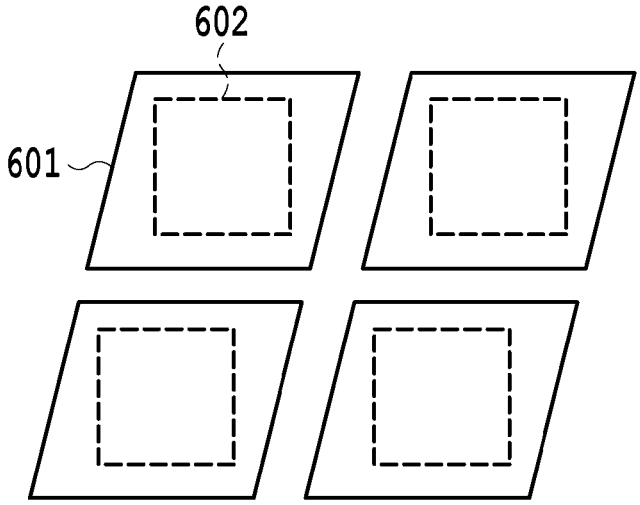


FIG.7A

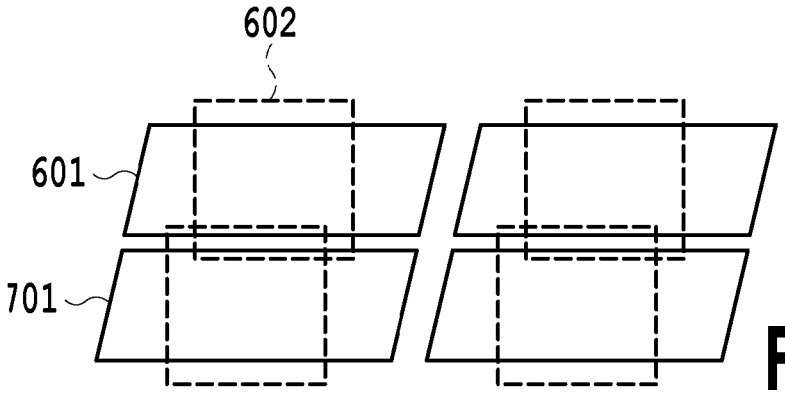


FIG.7B

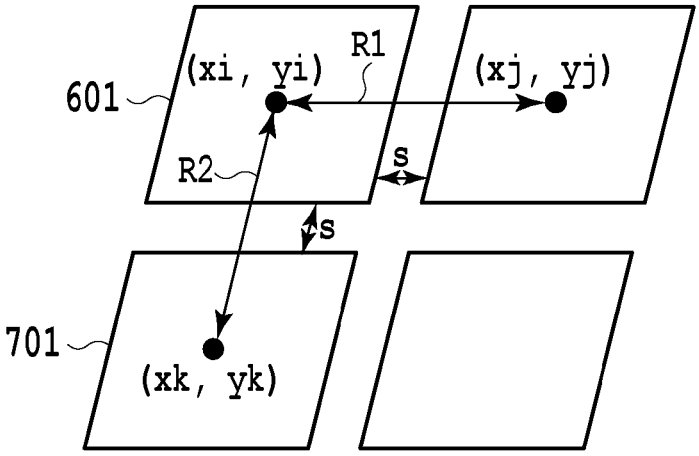


FIG.7C

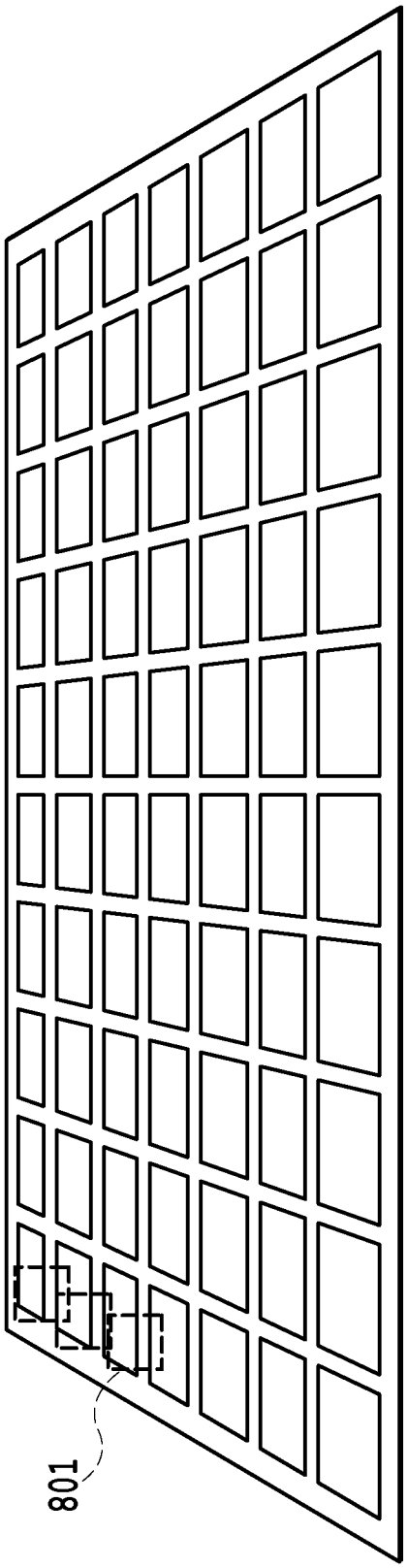


FIG.8

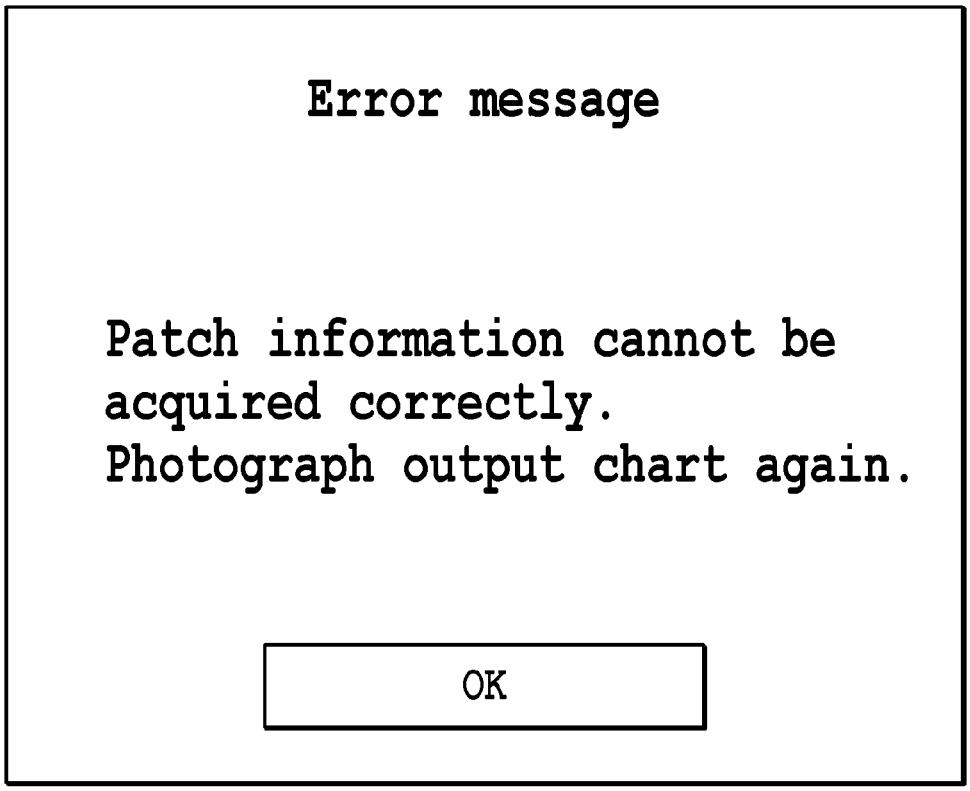

Error message
Patch information cannot be acquired correctly.
Photograph output chart again.
OK

FIG.9

Patch No	R	G	B
patch 1	XXX	XXX	XXX
patch 2	XXX	XXX	XXX
patch 3	XXX	XXX	XXX
patch 4	XXX	XXX	XXX
patch N	XXX	XXX	XXX

FIG.10

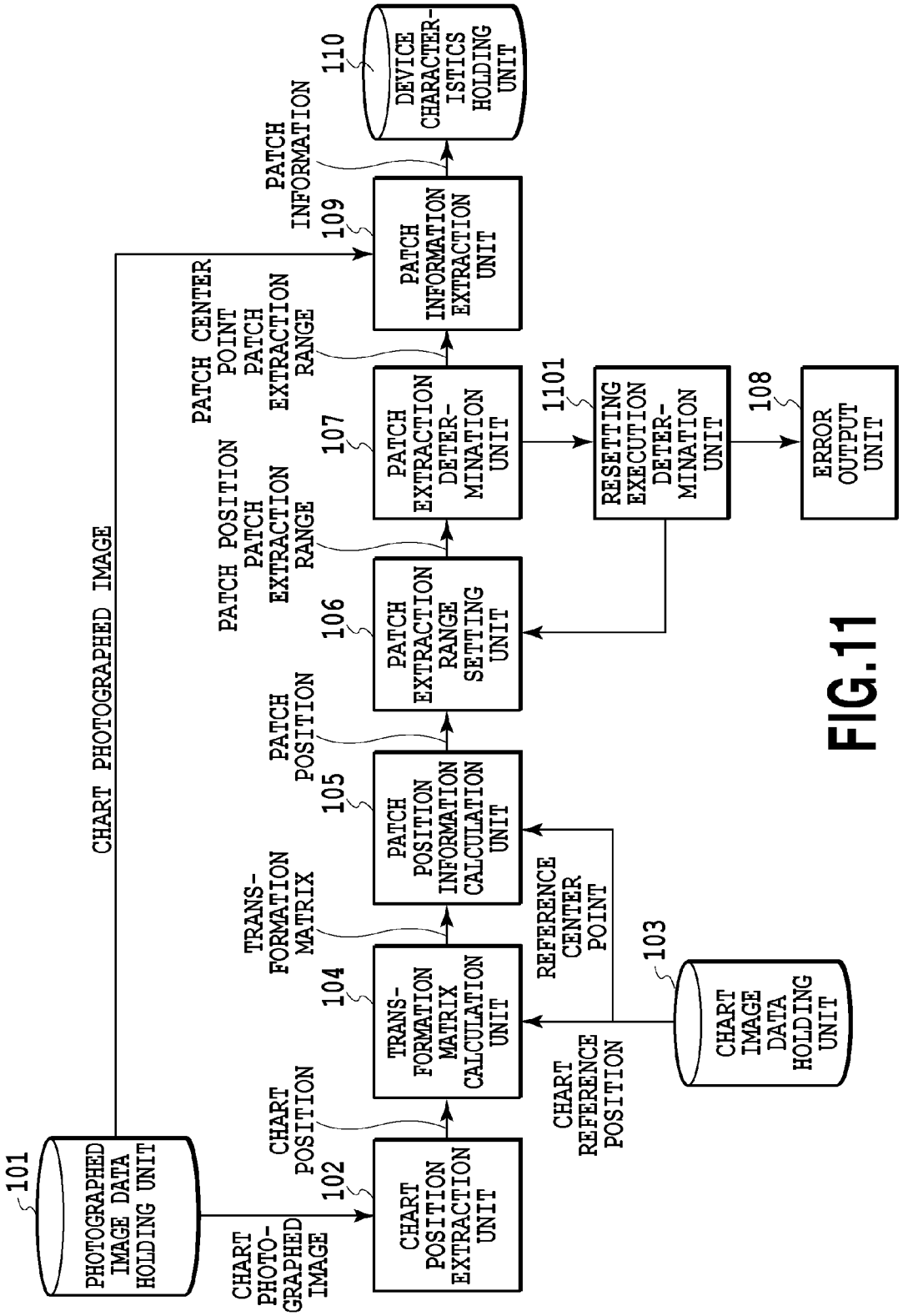

101
PHOTOGRAPHED IMAGE DATA HOLDING UNIT
CHART PHOTOGRAPHED IMAGE
CHART PHOTO-GRAPHED IMAGE
102
CHART POSITION EXTRACTION UNIT
CHART POSITION
104
TRANS-FORMATION MATRIX CALCULATION UNIT
TRANS-FORMATION MATRIX
105
PATCH POSITION INFORMATION CALCULATION UNIT
PATCH POSITION
106
PATCH EXTRACTION RANGE SETTING UNIT
PATCH POSITION
PATCH EXTRACTION RANGE
107
PATCH EXTRACTION DETER-MINATION UNIT
PATCH CENTER POINT
PATCH EXTRACTION RANGE
109
PATCH INFORMATION EXTRACTION UNIT
PATCH INFORMATION
110
DEVICE CHARACTER-ISTICS HOLDING UNIT
1101
RESETTING EXECUTION DETER-MINATION UNIT
108
ERROR OUTPUT UNIT
REFERENCE CENTER POINT
CHART REFERENCE POSITION
103
CHART IMAGE DATA HOLDING UNIT

FIG.11

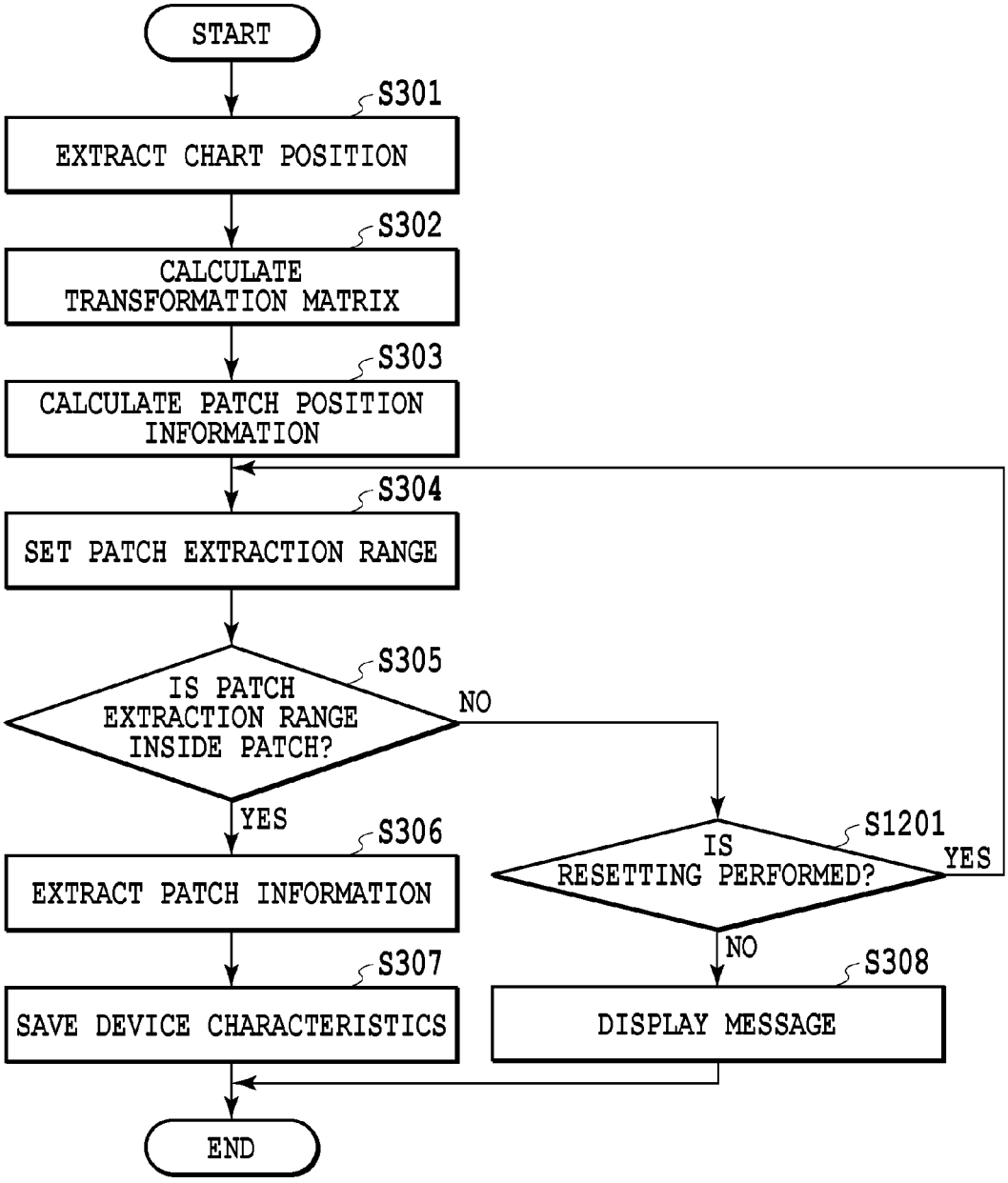

START
S301
EXTRACT CHART POSITION
S302
CALCULATE TRANSFORMATION MATRIX
S303
CALCULATE PATCH POSITION INFORMATION
S304
SET PATCH EXTRACTION RANGE
S305
IS PATCH EXTRACTION RANGE INSIDE PATCH?
NO
YES
S306
EXTRACT PATCH INFORMATION
S307
SAVE DEVICE CHARACTERISTICS
S1201
IS RESETTING PERFORMED?
YES
NO
S308
DISPLAY MESSAGE
END

FIG.12

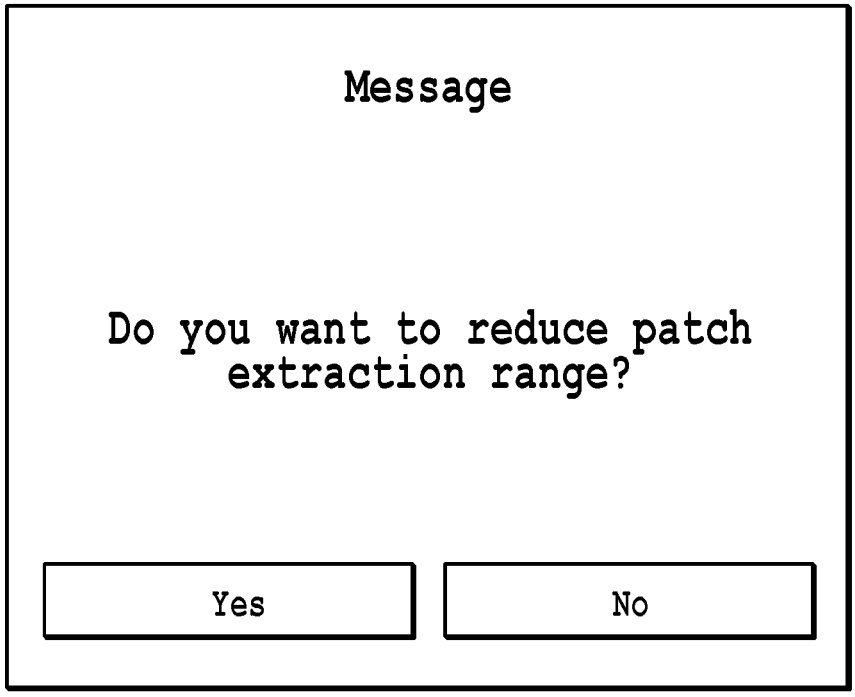


FIG.13A

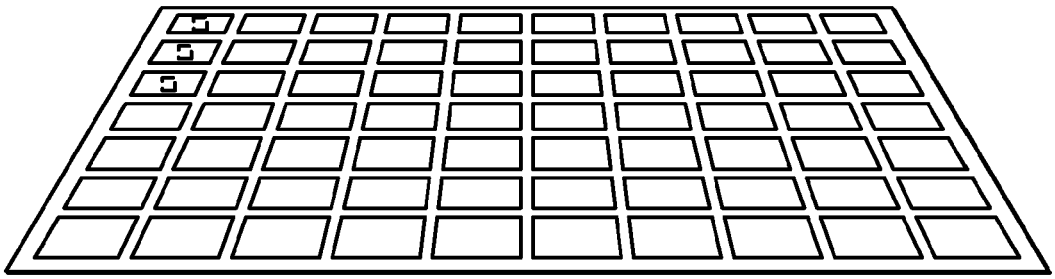


FIG.13B

FIG.14A

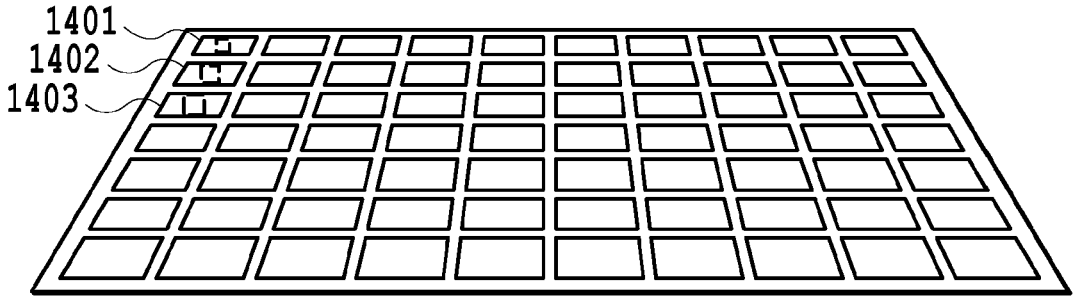


FIG.14B

IMAGE PROCESSING APPARATUS, IMAGE PROCESSING METHOD, AND MEDIUM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an image processing apparatus, an image processing method, and a medium for extracting characteristics of an object to be measured included in a photographed image.

2. Description of the Related Art

In the case where color reproduction characteristics of a device are measured, there is a method of performing measurement by displaying or outputting a patch for each color one by one by using the device. For example, there is a method of sequentially measuring images based on RGB data (729 (=9×9×9) colors in total) obtained by slicing the ranges of R, G, and B between 0 and 255 (0≤R, G, B≤255) into nine ranges, respectively, as patches. However, this method requires a number of measurement processes because measurement is performed for each color, and as a result, requires a long time in order to measure the color reproduction characteristics of one device.

Further, there is a method of displaying or outputting charts including all the color reproduction ranges of a device and measuring the charts at a time by using a two-dimensional measuring instrument such as a digital camera. Furthermore, a method of automatically measuring charts has been proposed. Japanese Patent Laid-Open No. 2008-278054 has proposed a method of extracting a chart area by analyzing color information along a plurality of directions perpendicular to one another in an image acquired by measuring a chart including an already-known background color using a two-dimensional measuring instrument.

Japanese Patent Laid-Open No. 2008-278054 premises that the patches included in the chart image acquired by using a two-dimensional measuring instrument are arranged along two directions perpendicular to each other. Because of this, the case where it is possible to accurately detect the chart area is limited to the case where the chart image can be acquired by using a two-dimensional measuring instrument in a position substantially facing the chart.

In the case where the two-dimensional measuring instrument does not face the chart perfectly, a distortion occurs in the chart in the image acquired by measurement. In the case where the extraction range of the patch is set uniquely in the chart having a distortion, there is a possibility that the extraction range will not fit inside the patch. In this case, it is not possible to extract the characteristics of the patch with accuracy, and as a result, there occurs such a problem that it is not possible to acquire the color characteristics of a device with high accuracy.

SUMMARY OF THE INVENTION

Because of this, in view of the above-described point, an object of the present invention is to provide an image processing apparatus capable of accurately acquiring patch information on each patch from a chart photographed image including a chart image having a distortion.

The present invention is an image processing apparatus that extracts colors of patches from a photographed image data of a chart image, the image processing apparatus comprising: a position extraction unit configured to extract information indicating a position of the chart image in the photographed image data; an acquisition unit configured to acquire information indicating a patch position of each patch images in the chart image based on the chart image; a setting unit configured to set an extraction range in accordance with the patch position of each of the patch images in the photographed image data based on the information; a determination unit configured to determine whether or not the set extraction range fits inside each of the patch images; and a color extraction unit configured to extract a color of each patch image based on pixel values of pixels included in the extraction range in a case where the determination unit determines that the extraction range fits inside each of the patch images for all the patch images.

Further features of the present invention will become apparent from the following description of exemplary embodiments (with reference to the attached drawings).

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram showing a configuration of an image processing apparatus in a first embodiment;

FIG. **2**A is a diagram showing an example of a chart image in the first embodiment;

FIG. **2**B is a diagram showing an example of a chart photographed image in the first embodiment;

FIG. **3** is a flowchart showing a flow of processing of the first embodiment;

FIGS. **4**A and **4**B are diagrams explaining an example of a method of extracting four vertexes of the chart photographed image;

FIG. **5**A is a diagram showing four vertexes in the chart image that are used for calculation of a transformation matrix H;

FIG. **5**B is a diagram showing the four vertexes in the chart photographed image that are used for the calculation of the transformation matrix H;

FIG. **6** is a diagram showing an example of a patch extraction range;

FIGS. **7**A, **7**B, and **7**C are diagrams explaining a setting method of a patch extraction range;

FIG. **8** is a diagram showing an example in which a patch extraction range reaches a neighboring patch;

FIG. **9** is a diagram showing an example of an error message;

FIG. **10** is a diagram showing an example of device characteristics;

FIG. **11** is a block diagram showing a configuration of an image processing apparatus in a second embodiment;

FIG. **12** is a flowchart showing a flow of processing of the second embodiment;

FIG. **13**A is a diagram showing an example of a message in the second embodiment;

FIG. **13**B is a diagram showing an example of a patch extraction range in the second embodiment;

FIG. **14**A is a diagram showing an example of a message in the second embodiment; and

FIG. **14**B is a diagram showing an example of a patch extraction range in the second embodiment.

DESCRIPTION OF THE EMBODIMENTS

Hereinafter, with reference to the attached drawings, the present invention is explained in detail based on preferred embodiments. Configurations shown in the following

embodiments are just illustrative and the present invention is not limited to the configurations shown schematically.

First Embodiment

About Configuration of Image Processing Apparatus

FIG. **1** is a block diagram showing a function configuration of an image processing apparatus in the present embodiment. In FIG. **1**, a photographed image data holding unit **101** is a database that holds chart photographed images. A chart position extraction unit **102** extracts information indicative of the position of a chart in the chart photographed image. A chart image data holding unit **103** is a database that holds chart images. A transformation matrix calculation unit **104** calculates a transformation matrix for transforming the coordinates of a chart image into the coordinates of a chart photographed image. A patch position information calculation unit **105** calculates information indicative of the position of each patch in the chart photographed image. A patch extraction range setting unit **106** sets a patch extraction range for each patch in the chart photographed image. A patch extraction determination unit **107** determines whether or not a patch extraction range set for each patch in the chart photographed image fits inside the patch. An error output unit **108** displays an error message. A patch information extraction unit **109** extracts patch information from the chart photographed image. A device characteristics holding unit **110** is a database that stores patch information extracted from the chart photographed image as characteristics inherent in the device.

The chart image in the present specification means original image data (electronic data) of a chart **202** in which rectangular patches **201** are arranged in regular order as shown in FIG. **2**A. The chart photographed image in the present specification is image data acquired by photographing a chart image output by or displayed on a device, which is the object of evaluation, by using a two-dimensional measuring instrument, such as a scanner and a digital camera. An example of the chart photographed image acquired by performing photographing using a digital camera is shown in FIG. **2**B. In the case where photographing is performed in the state where the output chart, which is to be photographed, and the digital camera with which photographing is performed are not facing each other perfectly, the shape of the chart and the shape of the patch in the chart photographed image are not rectangular and the shape is distorted and becomes close to a trapezoid as shown in FIG. **2**B.

(About Processing Performed by Image Processing Apparatus)

In the present embodiment, a chart photographed image acquired by performing photographing using a digital camera is prepared in advance and held in the photographed image data holding unit **101**, and patch information on each patch included in the chart in the chart photographed image is extracted. Further, as patch information on each patch, RGB values of each patch are extracted.

In the present embodiment, first, the position information on the chart is extracted from the chart photographed image and then the position information on each patch included in the chart is calculated. Next, the patch extraction range is set for the patch. In the case where the set patch extraction range fits inside each patch, the RGB values of pixels existing in an area included in the patch extraction range are extracted as patch information. Finally, the patch information that has been extracted for all the patches is saved as device characteristics inherent in the device that has output or displayed the chart. In the case where the set patch extraction range does not fit inside the patch, an error message is output.

The processing performed by the image processing apparatus shown in FIG. **1** is explained in detail by using the flowchart in FIG. **3**.

At step S**301** (hereinafter, step S**301** is abbreviated to "S**301**" and this also applies to the other steps), the chart position extraction unit **102** reads a chart photographed image from the photographed image data holding unit **101** and extracts the position information on the chart in the chart photographed image. Specifically, the chart position extraction unit **102** extracts the coordinates of the four vertexes of the chart in the chart photographed image as the position information on the chart. For example, in the case where the chart photographed image is an image shown in FIG. **4**A, the chart position extraction unit **102** extracts the coordinates of the four vertexes of the chart as the position information on the chart, on the assumption that a point distant from the top-left of the chart photographed image is defined as the origin and an x-direction and a y-direction are determined as shown in FIG. **4**B. Here, in the case where the top-left vertex, the top-right vertex, the bottom-right vertex, and the bottom-left vertex of the chart are taken to be A, B, C, and D in order, it is assumed that the coordinates of the four vertexes are (X**1**, Y**1**), (X**2**, Y**2**), (X**3**, Y**3**), and (X**4**, Y**4**), respectively, as shown in FIG. **4**B. As a method of extracting the four vertexes of the chart, for example, it is sufficient to display the chart photographed image on a display unit, such as a monitor, and to extract the four vertexes via instructions of a user via a user interface (UI).

At S**302**, the transformation matrix calculation unit **104** calculates a transformation matrix H for transforming coordinates in the chart image into coordinates of the corresponding position in the chart photographed image. The transformation matrix H is calculated by using the positions of the four vertexes in the chart image and the positions of the four vertexes in the chart photographed image.

A method of calculating the transformation matrix H is explained. First, the coordinates of the four vertexes of the chart image are extracted as chart reference positions. Specifically, as in the case of the coordinates set for the chart photographed image at S**301**, an xy-coordinate system with the top-left of the image being taken to be the origin is set also for the chart image as shown in FIG. **5**A and the coordinates of the four vertexes of the chart are extracted as chart reference positions. Here, in the case where the top-left vertex, the top-right vertex, the bottom-right vertex, and the bottom-left vertex of the chart are taken to be Ao, Bo, Co, and Do in order, it is assumed that the coordinates of the four vertexes are (Xo**1**, Yo**1**), (Xo**2**, Yo**2**), (Xo**3**, Yo**3**), and (Xo**4**, Yo**4**), respectively.

The transformation matrix H is calculated by using the coordinates of the four points Ao to Do in the chart image and the coordinates of the four points A to D in the chart photographed image set at S**301**. Specifically, by solving expression (1) below, it is possible to calculate the transformation matrix H.

$$\begin{bmatrix} X1 & X2 & X3 & X4 \\ Y1 & Y2 & Y3 & Y4 \\ 1 & 1 & 1 & 1 \end{bmatrix} = H \begin{bmatrix} Xo1 & Xo2 & Xo3 & Xo4 \\ Yo1 & Yo2 & Yo3 & Yo4 \\ 1 & 1 & 1 & 1 \end{bmatrix} \quad (1)$$

By using the transformation matrix H that is calculated by the above-described method, it is possible to transform the coordinates of the four points Ao to Do in the chart image into the coordinates of the four points A to D in the chart photographed image. Further, by using the transformation matrix H, it is possible to calculate the coordinates indicating an arbitrary position in the chart photographed image by transforming the coordinates indicating the corresponding position in the chart image.

At S**303**, the patch position information calculation unit **105** calculates the position information on each patch in the chart photographed image. Here, it is assumed that the center position of an ith patch i (i=1, 2, . . . , N) in the chart image is Po_i (xo_i, yo_i) (i=1, 2, . . . , N). It is also assumed that the center position of the ith patch in the chart photographed image is P_i (x_i, y_i) (i=1, 2, . . . , N). In this case, it is possible to calculate the center position P_i (x_i, y_i) of the patch i in the chart photographed image from expression (2) below by using the transformation matrix H calculated at S**302**.

$$P_i = H \cdot Po_i \ (i=1,2, \ldots ,N) \tag{2}$$

At S**304**, the patch extraction range setting unit **106** sets a patch extraction range for each patch. Specific explanation is given by using FIG. **6**. At the coordinates set at S**301**, a square area whose side has a length d and whose center is located at the center position P_i (x_i, y_i) of an ith patch **601** is set as a patch extraction range **602**.

At S**305**, the patch extraction determination unit **107** determines whether or not the patch extraction range fits inside the patch. As shown in FIG. **7**A, in the case where the patch extraction range **602** fits inside the ith patch **601**, it is possible to accurately extract patch information on the ith patch **601** to be extracted. However, as shown in FIG. **7**B, in the case where the patch extraction range **602** for the ith patch **601** reaches a neighboring patch **701**, the patch information on the neighboring patch **701** is also extracted at the time of extracting the patch information on the ith patch **601** to be extracted. Consequently, in this case, it is not possible to accurately extract the patch information on the ith patch **601**. Because of this, at this step, it is necessary for the patch extraction determination unit **107** to determine whether or not the patch extraction range fits inside the patch.

A specific determination method is explained by using FIG. **7**C. It is assumed that the center position of the ith patch **601** is P_i (x_i, y_i), the center position of the patch neighboring the patch **601** in the transverse direction is P_j (x_j, y_j), and the center position of the patch neighboring the patch **601** in the vertical direction is P_k (x_k, y_k). In this case, a distance R**1** between the patch **601** and the patch neighboring in the transverse direction and a distance R**2** between the patch **601** and the patch neighboring in the vertical direction are calculated by using expressions (3) and (4) below.

$$R1 = x_j - x_i \tag{3}$$

$$R2 = y_k - y_i \tag{4}$$

Next, determination using expressions (5) and (6) below is performed for the calculated R**1** and R**2**. Here, s in expressions (5) and (6) is the distance between the patches at the coordinates set at S**302**.

$$R1 > d + s \tag{5}$$

$$R2 > d + s \tag{6}$$

In the case where both expressions (5) and (6) hold, it is determined that the patch extraction range fits inside the ith patch **601** and the processing proceeds to S**306**. At least one of expressions (5) and (6) does not hold, it is determined that the patch extraction range **602** set for the ith patch **601** reaches the neighboring patch, and the processing proceeds to S**308**.

At S**306**, the patch information extraction unit **109** extracts a pixel value, specifically, RGB values, of each patch from the chart photographed image based on the patch position information calculated by the patch position information calculation unit **105** and the patch extraction range set by the patch extraction range setting unit **106**. In the present embodiment, it is assumed that RGB values of each patch are values obtained by averaging R values, G values, and B values, respectively, of the pixels included in the patch extraction range of each patch.

At S**307**, the device characteristics holding unit **110** saves the patch information extracted by the patch information extraction unit **109** from all the patches as device characteristics inherent in the device. The patch information about all the patches is, for example, a table in which the patch number and the RGB values are associated with each other as shown in FIG. **10**.

At S**308**, the error output unit **108** outputs an error message. For example, in the case where the distortion in the chart shape in the chart photographed image is large as shown in FIG. **8**, a patch extraction range **801** of a certain patch reaches the neighboring patch. Consequently, it is not possible to set a patch extraction range inside each patch in the chart photographed image, and therefore, it is not possible to accurately extract the patch information on each patch. Because of this, in the present embodiment, a message as illustrated in FIG. **9** is output to a user to prompt the user to acquire the chart photographed image again. It is sufficient to display this message, for example, on a display device connected to a PC that operates the image processing apparatus according to the present embodiment, or to a PC that functions as the image processing apparatus according to the present embodiment.

As above, in the present embodiment, by using the transformation matrix that is calculated based on the coordinates of the four vertexes of the chart extracted from the chart photographed image, the position information on the patch within the chart photographed image is calculated and the patch extraction range is set for each patch. Then, in the case where the patch extraction range fits inside the patch, the patch information is extracted and the patch information on all the patches is saved as the device characteristics. In other words, due to the present embodiment, it is made possible to accurately extract patch information also in the case where there is a distortion in the shape of the chart in the chart photographed image. On the other hand, in the case where the patch extraction range reaches the neighboring patch, it is determined that the patch information cannot be acquired correctly and an error message to prompt a user to photograph the chart again is output.

In the present embodiment, the patch extraction range is a square area, but the shape of the patch extraction range is not limited to a square. It may also be possible to set the shape of the patch extraction range to an arbitrary quadrangle, such as a rectangle and a parallelogram, or an arbitrary circle in accordance with the shape of the patch in the chart image or the shape of the patch in the chart photographed image. Even in the case where the shape of the patch extraction range changes, it is only required for the patch extraction determination unit **107** to be capable of determining whether or not the patch extraction range fits inside the patch. Further, in the present embodiment, the

case is explained as an example where the patch-to-patch distance between patches neighboring in the transverse direction and the patch-to-patch distance between patches neighboring in the vertical direction are equal, but it is also possible to apply the present invention to the case where these patch-to-patch distances are different.

Second Embodiment

In the first embodiment, the patch extraction range is set for the patch in the chart photographed image. Then, in the case where the patch extraction range reaches the neighboring patch, the patch extraction determination unit **107** determines that the patch information cannot be acquired correctly and the error output unit **108** outputs an error message to prompt a user to photograph the chart again.

However, in the first embodiment, in order to obtain a chart photographed image with no distortion so that the patch extraction range fits inside the patch, a new process to perform photographing again is necessary. Further, the message to be displayed is not limited to that described above (see FIG. **9**). It may also be possible to output a message to the effect that the patch extraction range should be set again for the patch of the chart photographed image input to the image processing apparatus, in place of the message to prompt a user to photograph the chart again.

Consequently, in the present embodiment, the case is explained where the patch extraction range setting unit **106** sets the patch extraction range again in accordance with a message other than the message displayed by the error output unit **108** of the first embodiment. In the following explanation of the present embodiment, explanation of the contents in common to those of the first embodiment is simplified or omitted.

(About Configuration of Image Processing Apparatus)

FIG. **11** is a block diagram showing a function configuration of an image processing apparatus in the present embodiment. The image processing apparatus according to the present embodiment differs from that according to the first embodiment in including a resetting execution determination unit **1101** in the subsequent stage of the patch extraction determination unit **107**, which is also the previous stage of the error output unit **108**. The resetting execution determination unit **1101** determines whether or not to perform resetting of the patch extraction range in accordance with instructions from a user.

(About Processing Performed by Image Processing Apparatus)

The processing that is performed in the present embodiment is explained by using the flowchart in FIG. **12**. However, the same symbol as that in FIG. **3** is attached to the same processing as that of the first embodiment and explanation thereof is omitted.

At step **1201**, the resetting execution determination unit **1101** displays, for example, a message to ask whether or not to reduce the patch extraction range as shown in FIG. **13**A and determines whether or not to perform resetting of the patch extraction range based on the instructions from a user. In the case where the user selects "Yes" in response to this message, the processing returns to S**304** and the patch extraction range setting unit **106** performs a setting so as to reduce the patch extraction range. Specifically, as shown in FIG. **13**B, the patch extraction range setting unit **106** performs a setting so as to reduce the patch extraction range in accordance with the smallest patch in the chart photographed image. For example, in the first embodiment, the length of one side of the square, which is the shape of the patch extraction range, is set to d, but in the present embodiment, it is sufficient to set the length of one side of the square of the patch extraction range to ½d. In the case where the user selects "No", the processing proceeds to S**308** and the message as in FIG. **9** is displayed to prompt the user to photograph the chart again, and the series of the processing is exited.

As above, in the present embodiment, in the case where the patch extraction range does not fit inside the patch, the resetting execution determination unit **1101** outputs a message that prompts resetting of the patch extraction range. Due to the present embodiment, it is possible to extract the patch characteristics using the chart photographed image input to the image processing apparatus as it is by setting a reduced patch extraction range without the need to photograph the patch again.

It may also be possible to enable a user select a setting of the patch extraction range for each patch by displaying a message as shown in FIG. **14**A. In the case where the user selects "Yes" in response to this message, the processing returns to S**304** and the patch extraction range setting unit **106** sets the patch extraction range for each patch. Specifically, the patch extraction range setting unit **106** sets the patch extraction range in accordance with the patch in the chart photographed image as shown in FIG. **14**B. For example, for a patch **1401** in FIG. **14**B, the length of one side of the square, which is the shape of the patch extraction range, is set to d/2, which is half the length d of one side of the square, which is the shape of the patch extraction range in the first embodiment. Further, for a patch **1402**, the length of one side of the square, which is the shape of the patch extraction range, is set to 2d/3. In the case where the user selects "No", the message as shown in FIG. **9** is displayed to prompt the user to photograph the chart again, and the series of the processing is exited.

Other Embodiments

Embodiment(s) of the present invention can also be realized by a computer of a system or apparatus that reads out and executes computer executable instructions (e.g., one or more programs) recorded on a storage medium (which may also be referred to more fully as a 'non-transitory computer-readable storage medium') to perform the functions of one or more of the above-described embodiment(s) and/or that includes one or more circuits (e.g., application specific integrated circuit (ASIC)) for performing the functions of one or more of the above-described embodiment(s), and by a method performed by the computer of the system or apparatus by, for example, reading out and executing the computer executable instructions from the storage medium to perform the functions of one or more of the above-described embodiment(s) and/or controlling the one or more circuits to perform the functions of one or more of the above-described embodiment(s). The computer may comprise one or more processors (e.g., central processing unit (CPU), micro processing unit (MPU)) and may include a network of separate computers or separate processors to read out and execute the computer executable instructions. The computer executable instructions may be provided to the computer, for example, from a network or the storage medium. The storage medium may include, for example, one or more of a hard disk, a random-access memory (RAM), a read only memory (ROM), a storage of distributed computing systems, an optical disk (such as a compact disc (CD), digital versatile disc (DVD), or Blu-ray Disc (BD)™), a flash memory device, a memory card, and the like.

According to the above embodiments, it is possible to accurately acquire patch information from a patch image having a distortion at the time of measuring a chart using a digital camera or the like as a measuring instrument.

While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

This application claims the benefit of Japanese Patent Application No. 2014-110485, filed May 28, 2014, which is hereby incorporated by reference wherein in its entirety.

What is claimed is:

1. An image processing apparatus that extracts colors of patches from a photographed image data of a chart image, the image processing apparatus comprising:

a processor connected to a memory, the processor and memory configured to:

extract information indicating a position of the chart image in the photographed image data;

acquire information indicating a patch position of each patch images in the chart image based on the chart image;

set an extraction range in accordance with the patch position of each of the patch images in the photographed image data based on the information;

determine whether or not the set extraction range fits inside each of the patch images; and

extract a color of each patch image based on pixel values of pixels included in the extraction range in a case where it is determined that the extraction range fits inside each of the patch images for all the patch images.

2. The image processing apparatus according to claim **1**, the processor and memory further configured to display an error message in a case where it is determined that the extraction range of a certain patch image does not fit inside the certain patch image.

3. The image processing apparatus according to claim **1**, the processor and memory further configured to hold patch information extracted from the photographed image data as a characteristic inherent in a device.

4. The image processing apparatus according to claim **1**, wherein

information indicating the position of the chart image is extracted in accordance with instructions from a user via a user interface.

5. The image processing apparatus according to claim **1**, the processor and memory further configured to determine whether or not to perform resetting of the extraction range in a case where it is determined that the extraction range of a certain patch image does not fit inside the certain patch image.

6. The image processing apparatus according to claim **5**, wherein

the extraction range is reduced in a case where it is determined to perform resetting of the extraction range.

7. The image processing apparatus according to claim **5**, wherein

an extraction range is set in accordance with an area size of each patch image in a case where it is determined to perform resetting of the extraction range.

8. An image processing method performed by an image processing apparatus that extracts colors of patches from a photographed image data acquired by photographing a chart image, the method comprising:

extracting information indicating a position of the chart image in the photographed image data;

acquiring information indicating a patch position of each patch images in the chart image based on the chart image;

setting an extraction range in accordance with the patch position of each of the patch images in the photographed image data based on the information;

determining whether or not the set extraction range fits inside each of the patch images; and

extracting a color of each patch image based on pixel values of pixels included in the extraction range in a case where it is determined that the extraction range fits inside each of the patch images for all the patch images.

9. A non-transitory computer readable storage medium storing a program for causing a computer to perform an image processing method that extracts colors of patches from a photographed image data acquired by photographing a chart image, the method comprising:

extracting information indicating a position of the chart image in the photographed image data;

acquiring information indicating a patch position of each patch images in the chart image based on the chart image;

setting an extraction range in accordance with the patch position of each of the patch images in the photographed image data based on the information;

determining whether or not the set extraction range fits inside each of the patch images; and

extracting a color of each patch image based on pixel values of pixels included in the extraction range in a case where it is determined that the extraction range fits inside each of the patch images for all the patch images.

* * * * *